

U.S. Patent Application Serial No. 09/743,531
Response dated March 15, 2004
Reply to OA of November 13, 2003

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (Cancel)

Claim 2 (Currently Amended): A micro-bubble generating system, comprising a container main unit having an interior space of frusto-conical shape and being closed at one end, a pressurized liquid inlet opening communicating tangentially with said interior space, a gas introducing hole opening at one end of said frusto-conical space to generate a swirling gas that is ~~exposed to contact with~~ directly impinged upon by swirling pressurized liquid introduced through said liquid inlet, and a swirling gas-liquid mixture outlet ~~opened~~ opening at the other end of said interior space and operative to discharge micro-bubbles therefrom.

Claim 3 (Currently Amended): A micro-bubble generating system according to one of claims 2 or 10, wherein a plurality of pressurized liquid ~~inlets open in tangential direction~~ inlet openings are tangentially disposed on a part of a circumferential surface of ~~an inner wall of the space~~ are the container and communicate at spaced locations about the circumference of the ~~inner container~~ inner container wall ~~[[of]]~~ with the interior space.

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Claim 4 (Currently Amended): A micro-bubble generating system according to one of claims 2 or 10, wherein ~~[[a]] said pressurized liquid introducing hole is opened~~ inlet opening opens on a part of the circumferential surface of ~~inner wall~~ the container near ~~[[a]] said~~ gas-mixture outlet from said interior space.

Claim 5 (Canceled)

Claim 6 (Withdrawn): A micro-bubble generating system according to one of claims 1 or 2, wherein a baffle plate is arranged closely spaced from the swirling gas-liquid mixture outlet from the interior space.

Claim 7 (Withdrawn): A micro-bubble generating system according to one of claims 1 or 2, wherein a partition plate for closing the outlet is attached, leaving only a partial opening defining the swirling gas-liquid mixture outlet from the interior space.

Claim 8 (Currently Amended): A method for micro-bubble generation, using a micro-bubble generating system, which comprises a container main unit having an interior space with a bottom, a pressurized liquid inlet opened in a tangential direction on a part of a circumferential surface of an inner wall of the space, a gas introducing hole opened at the bottom of the interior space, and a swirling gas-liquid mixture outlet opened at a mixture discharge end of the interior space, whereby said method ~~comprises~~ comprising the steps of:

~~a first step of forming a swirling gas cavity for swirling and guiding along which~~ self-sucked gas is swirled and guided while ~~extending and narrowing down the flowing in a narrow stream of~~ swirling gas flow in the interior space; and

~~a second step of~~ generating micro-bubbles by forcibly cutting off and ~~smashing directly~~ impinging the swirling gas cavity ~~by contact~~ with swirling pressurized liquid [[due]] to generate a difference of swirling velocity between the gas and liquid portions in the swirling gas cavity.

Claim 9 (Currently Amended): A method for micro-bubble generation, using a micro-bubble generating system, which comprises a container main unit having an interior space with a bottom, a pressurized liquid inlet opened in a tangential direction on a part of a circumferential surface of an inner wall of the space, a gas introducing hole opened at the bottom of the interior space, and a swirling gas-liquid mixture outlet opened at a mixture discharge end of the interior space, whereby said method ~~comprises~~ comprising the steps of:

~~a first step of forming a swirling gas cavity for swirling and guiding self-sucked gas while~~ extending and narrowing down the along a narrow gas flow stream in the interior space;

~~a second step of~~ generating micro-bubbles by forcibly cutting off and ~~smashing directly~~ impinging the swirling gas cavity ~~by contact~~ with swirling pressurized liquid [[due]] to generate a difference of swirling velocity between the portions in the swirling gas cavity; and

~~a third step of~~ continuously cutting off and ~~smashing directly impinging~~ the swirling gas cavity in said interior space [[due]] to generate a relative increase of the difference in rotating

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velocity between ~~[[the]]~~ a rotating cut-off portion and ~~smashing impinged~~ portion in the second step, the liquid passing through the rotating cut-off portion ~~[[is]]~~ of gas cavity being rapidly expanded in conical shape diffused while ~~rotating~~ (where the fluid not containing micro-bubbles is filled in the rotating fluid expanding in conical shape) the diffused rotating gas fluid mixture fluid expanding in conical shape is stably formed~~[[,]]~~ and expanding an angle of conical shape diffusion of the rotating mixture is large (about 90°), and wherein a rotating difference of rotating velocity between gas and liquid streams is relatively increased between the rotating cut-off portion and the smashing impinged portion of the swirling gas cavity portion in the second step.

Claim 10 (New): A micro-bubble generating system, comprising:

- a container defining a cylindrical interior space,
- a container bottom closing said space at one axial end thereof and a gas-liquid mixture outlet opening at the other end thereof,
- a liquid inlet opening communicating tangentially with said interior space adjacent said gas-liquid mixture outlet opening,
- means for injecting pressurized liquid through said liquid inlet opening as a centrifugally flowing fluid into said interior space,
- a gas introducing hole disposed in the container bottom and operative to introduce gas into said interior space, said stream of gas being induced to swirl as a narrow low pressure flow stream in said interior space by said centrifugally flowing liquid,

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wherein said swirling pressurized liquid introduced through said pressurized liquid inlet directly impinges on said narrow swirling gas flow stream adjacent said gas-liquid mixture outlet to tear down said swirling gas flow stream and thereby generate micro-bubbles for discharge from said gas-liquid mixture outlet opening.